



J1 VIIRS Waiver Mitigations

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August 26, 2015



Outline



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 - Other J1 waiver mitigation efforts
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J1 VIIRS Waivers Overview



- The Joint Polar Satellite System (JPSS-1, J1) satellite is scheduled to be launched in early 2017.
- J1 VIIRS sensor performance exceeds/meets requirements in most cases.
- Non compliances are addressed in performance waivers and their impact assessments



J1 VIIRS Waivers Overview



J1 Waivers	Description	Impacts
DNB Non-linearity	High nonlinearity in radiometric response especially at edge of scan	Major Require aggregation mode change (Op21, Op21/26) → Require GEO code change
DNB Stray Light	When VIIRS itself is sunlit and DNB is viewing night side of the earth	Major; same methodology used for S-NPP can be adapted to make corrections
Polarization Sensitivity	Linear polarization sensitivity (M1-M4)	Moderate Degraded OC/aerosols products Striping
SWIR non-linearity and uncertainty	SWIR M-bands at low radiance	Minor for AOT; Major for OC, esp. in coastal zones; SDR Science code change required to improve calibration accuracy
Emissive band radiometric calibration	RRU: M12, M13(HG), & M14 RRCU: M12 & I5	Minor Cloud, cryosphere products Striping ; low temperature bias



J1 VIIRS Waivers Overview



J1 Waivers	Description	Impacts
Spatial Resolution-DFOV	J1 smaller DFOV due to normal sensor-to sensor build variability	Minor; AF detection & consistency btw satellites
Spatial Resolution -MTF	M1-M7/M13	Major; AF, coastal OC may be impacted
Crosstalk	Dominated by static electrical crosstalk	Moderate on OC
Near Field Response (NFR)	M7, M13, M16A; I3	Moderate for AF Minor for OC
Dynamic Range	M5LG, M8 , M9, M10, M11, I1, I3 , and I4 saturation; DNB	Minor for Nightfire; moderate for AF, COP, cloud mask and down-stream products
Relative Spectral Response (RSR)	Mainly in several SWIR&LWIR bandpass/center wavelength	Small; Potential inconsistency in time series compared to S-NPP
Band-to-Band Registration (BBR)	Dominated by in-track registration; I-bands	Minor; potential impact on cloud mask & AF product



J1 VIIRS Waivers Overview



- J1 waivers has been discussed extensively and their impacts have been studied by VIIRS SDR & EDR teams:
 - Most waivers have small to negligible impacts on EDR performance;
 - Certain waivers need to be mitigated at the SDR level and require science code change;
 - The remaining waivers are mitigated at the EDR level.



Objectives



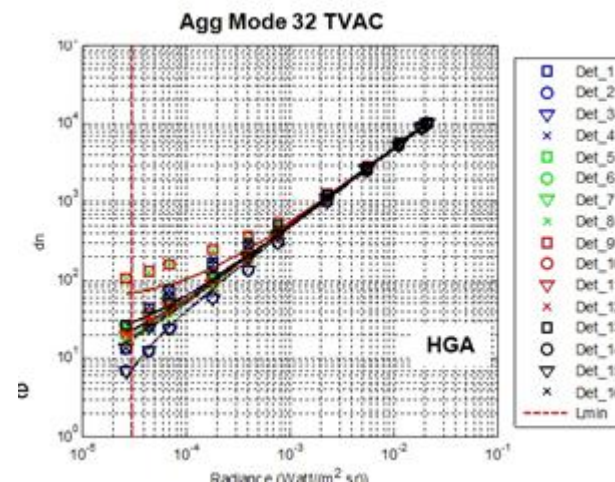
STAR VIIRS SDR Team's efforts to mitigate J1 waivers

- VIIRS GEO code change to accommodate DNB AggMode change
- DNB stray light correction
- Assessing impact of J1 polarization sensitivity on SDR products
- Other waiver mitigation efforts

VIIRS GEO Code Change

-DNB non-linearity waiver

- J1 VIIRS DNB has high nonlinearity in radiometric response especially at edge of scan based on prelaunch tests, which is different from the behavior of the SNPP VIIRS
- Two options have been proposed by the J1 data working group:
 - Op21 (Baseline)**
Extend AggMode 21 up to 32
 - Op21/26**
Extend AggMode 21 up to 25
Extend AggMode 26 up to 32





VIIRS GEO Code Change



- SNPP SDR science code analysis indicates that VIIRS radiometric calibration code does not require a modification for J1
- However, current geolocation code cannot deal with the new J1 aggregation schemes properly
 - J1 DNB aggregation zones are **asymmetric**, different from SNPP
 - **Hard-coded** DNB EV nadir frame # & aggregation zones
- Without code change, J1 DNB geolocation products will not be generated correctly



J1 VIIRS GEO Code Change Scheme



- Using Block 2 ADL as baseline
- The dimensions of GEO-DNB-PARAM-LUT are unchanged
 - Contents are updated for J1
- Modify code to accommodate J1 DNB aggregation mode change
 - Does not change the core of VIIRS geolocation algorithm
 - Derives correct agg. zone & nadir frame # solely from geoParams LUTs
- The modified code is designed to be backward compatible with SNPP and supports both Op21 and Op21/26 for J1



Scope of VIIRS GEO Code



GEO_determine_DNB_sample_time_offsets.cpp

- } 1. Determine DNB sample time offsets

GEO_interpolate_mirror_encoder.cpp

GEO_interpolate_telescope_encoder.cpp

- } 2. Extrapolating of encoder data

ProSdrViirsGeoDataStructs.h

GEO_process_parameters.cpp

fixSatAngles.cpp

ProSdrViirsGeo.cpp

geolocateDecim.cpp

geolocateAllRecPix.cpp

- } 3. Hard-coded nadir frame #

Files with red color have relatively more changes.

GEO_parameters.h

ProViirsGeoRectangle.h

ProGeoloc_createInterpRectangles.cpp

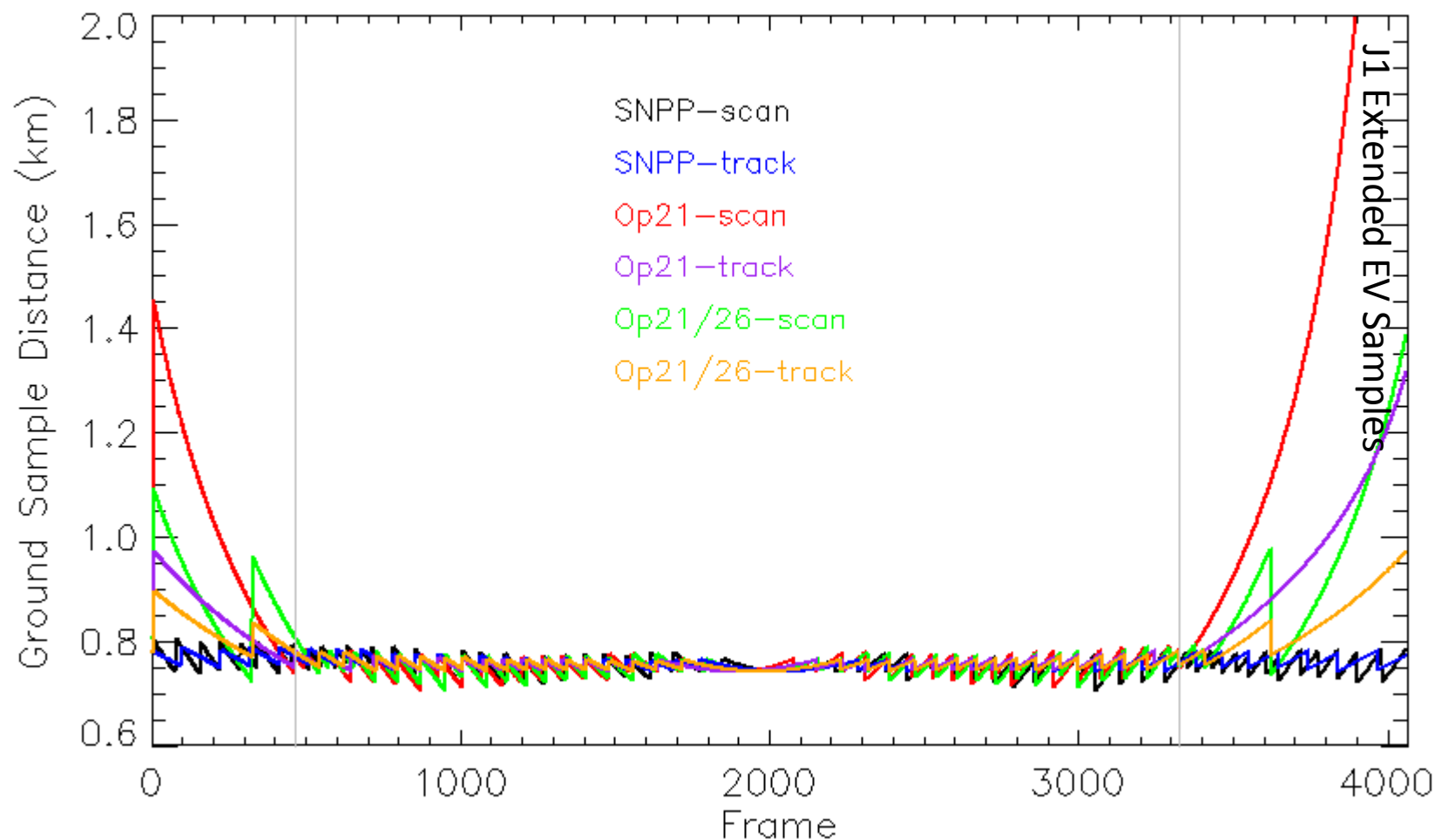
calcModFromImg.cpp

geolocateGranule.cpp

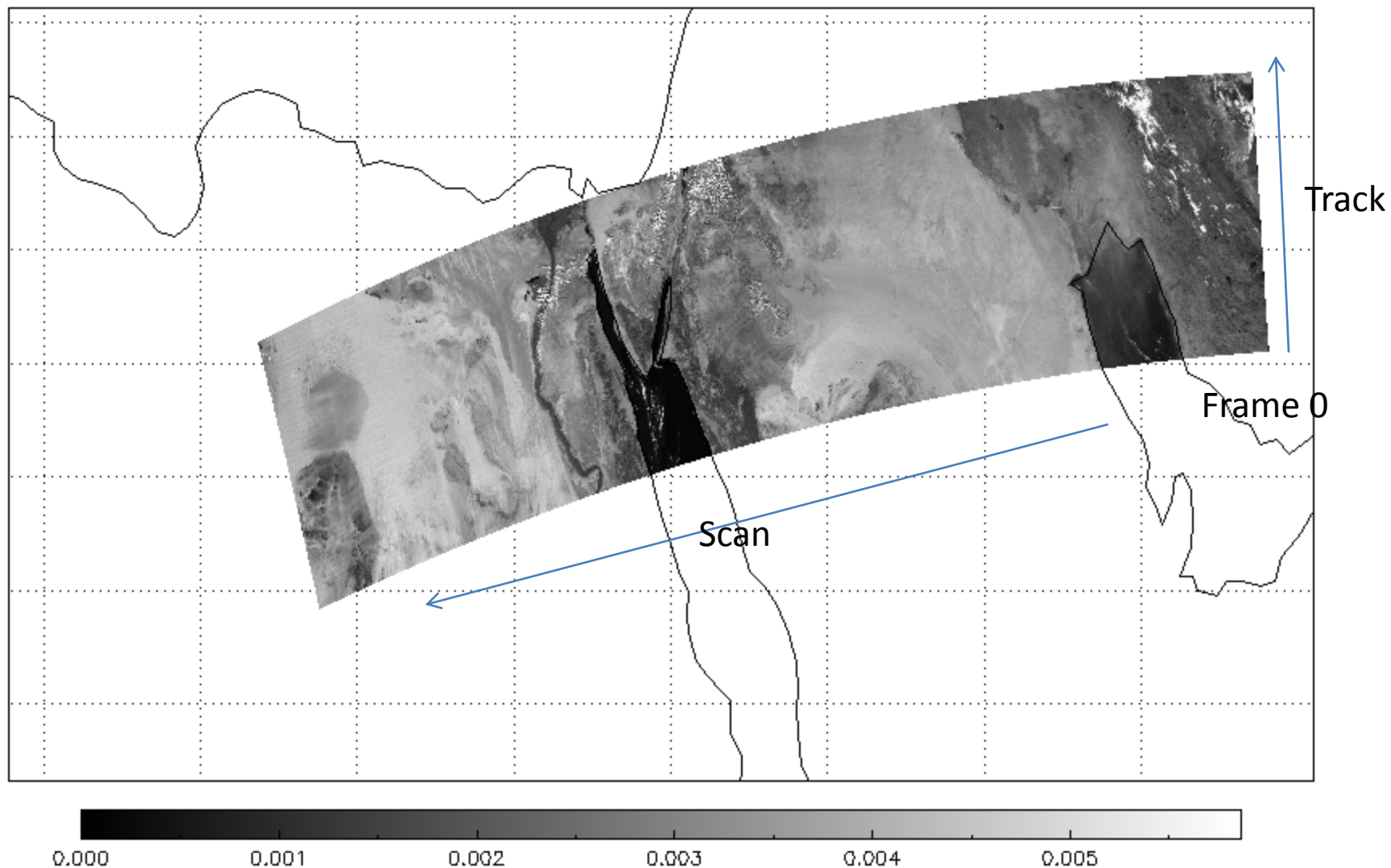
- } 4. Interpolation rectangles

- Totally 14 files were modified (~165 lines)

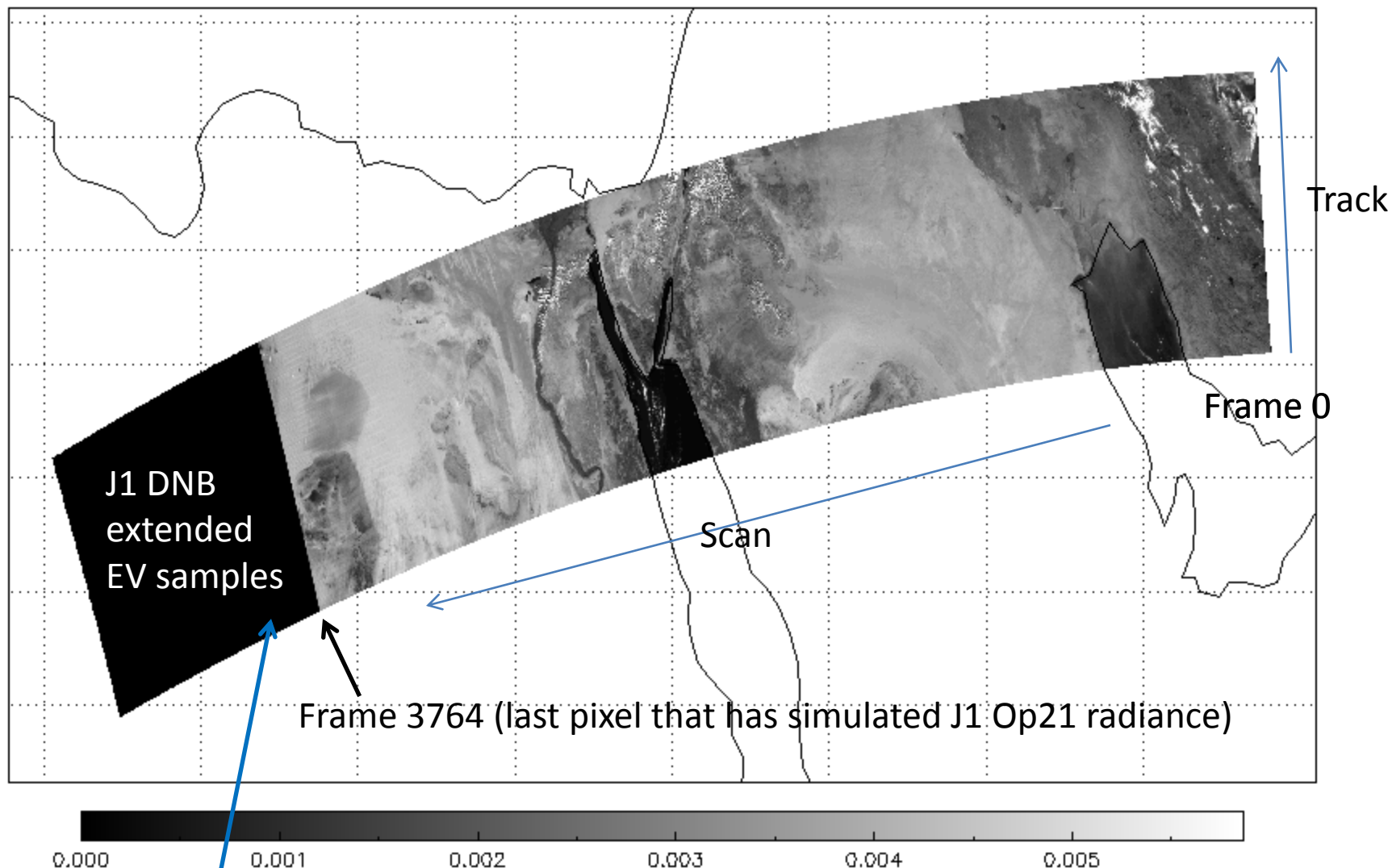
SNPP , Op21, Op21/26



Original SNPP Radiance

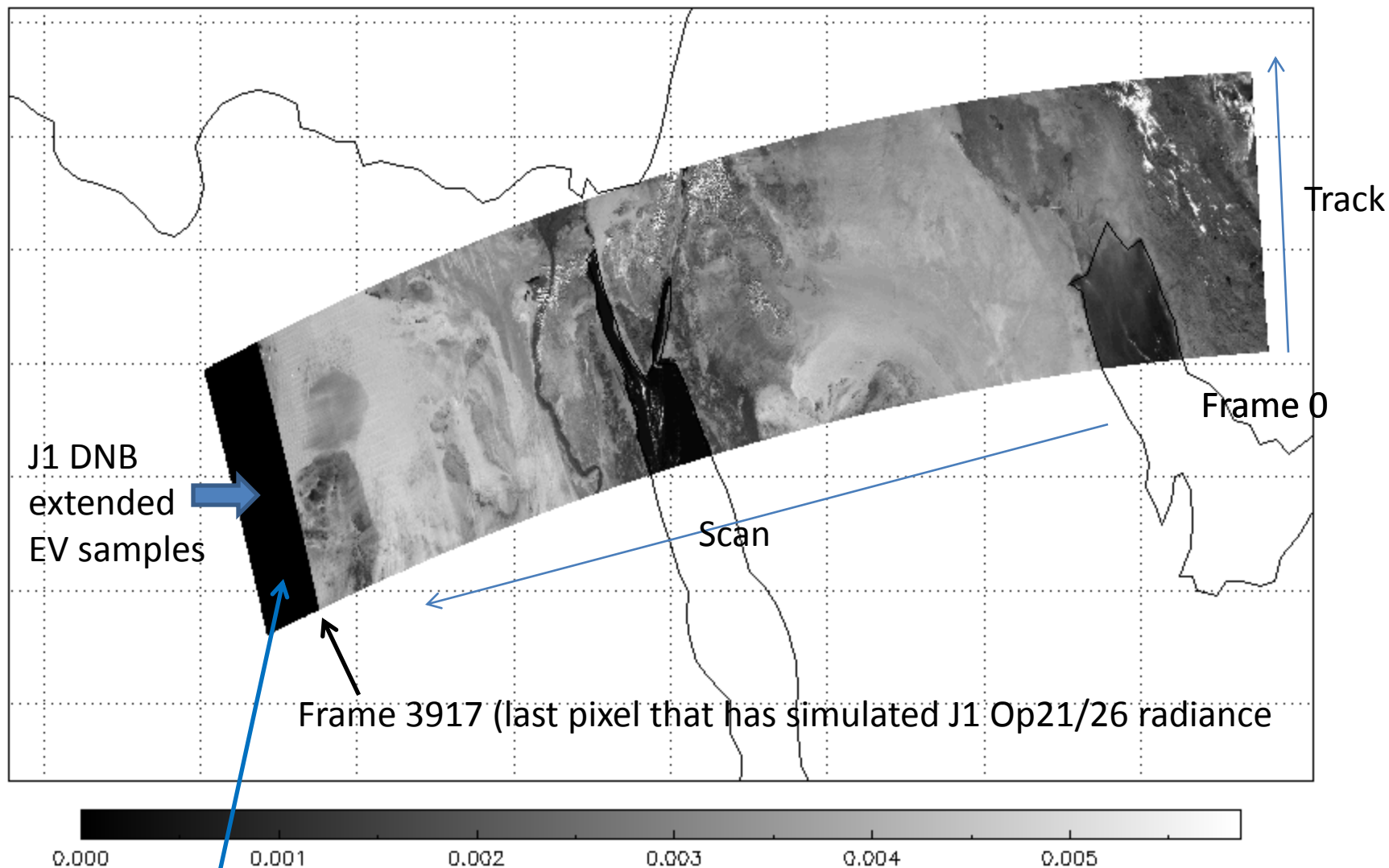


J1 Code Change (J1 Op21)



After frame 3805, lat/lon are calculated using extrapolated encoder data

J1 Code Change (J1 Op21/26)

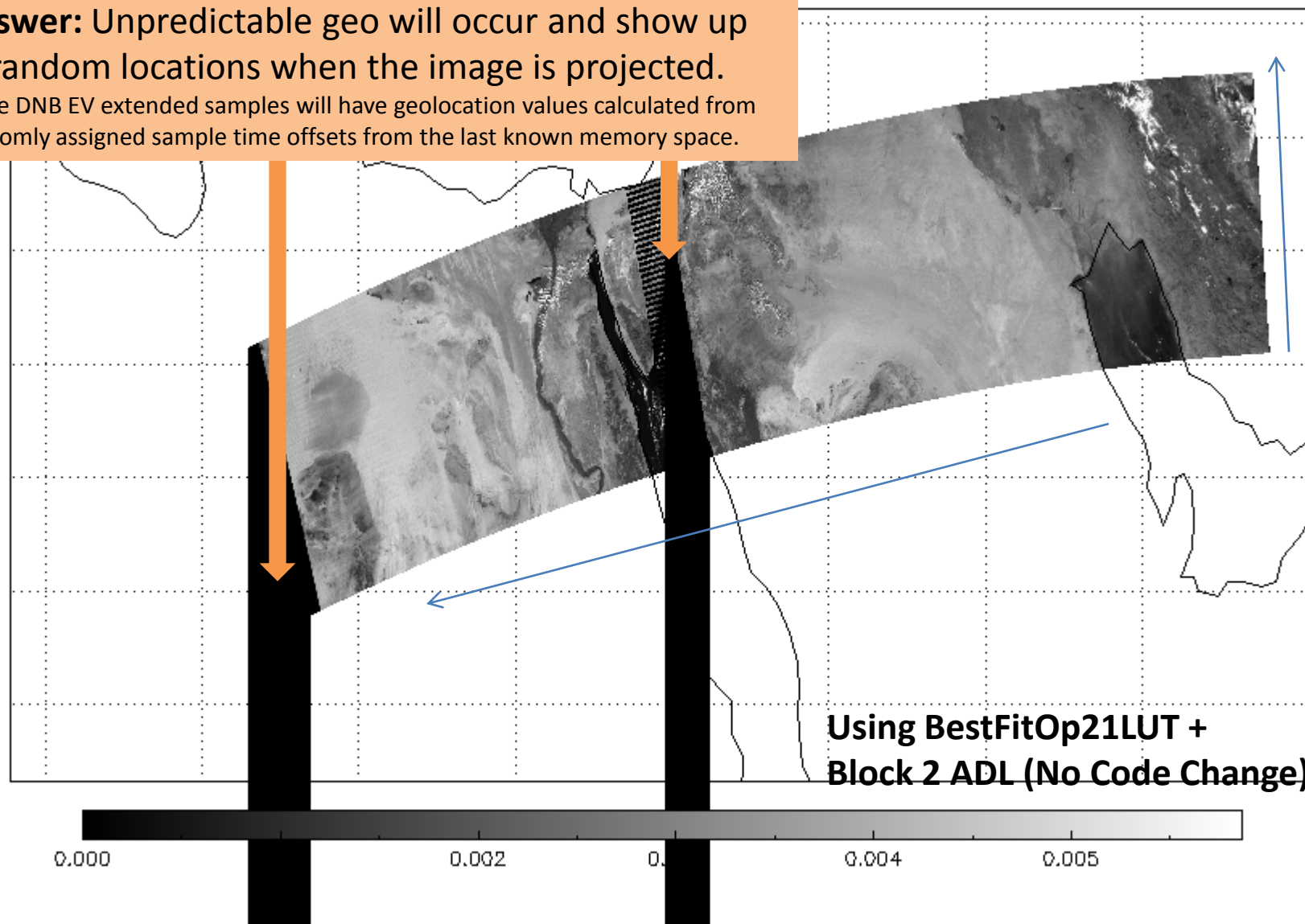


After frame 3972, lat/lon are calculated using extrapolated encoder data

What if the GEO code is not changed?

Answer: Unpredictable geo will occur and show up in random locations when the image is projected.

Some DNB EV extended samples will have geolocation values calculated from randomly assigned sample time offsets from the last known memory space.





Status of VIIRS GEO Code Change



- **STAR VIIRS SDR team has successfully completed the GEO code change package.**
 - Tested using Block 2 ADL and simulated J1 RDRs & SDRs.
- **The package was peer-reviewed by NASA VCST, Aerospace, Raytheon, and the STAR VIIRS SDR team**
- **It has been tested by STAR AIT and delivered to DPE on schedule (Aug 7, 2015) for further test and integration.**

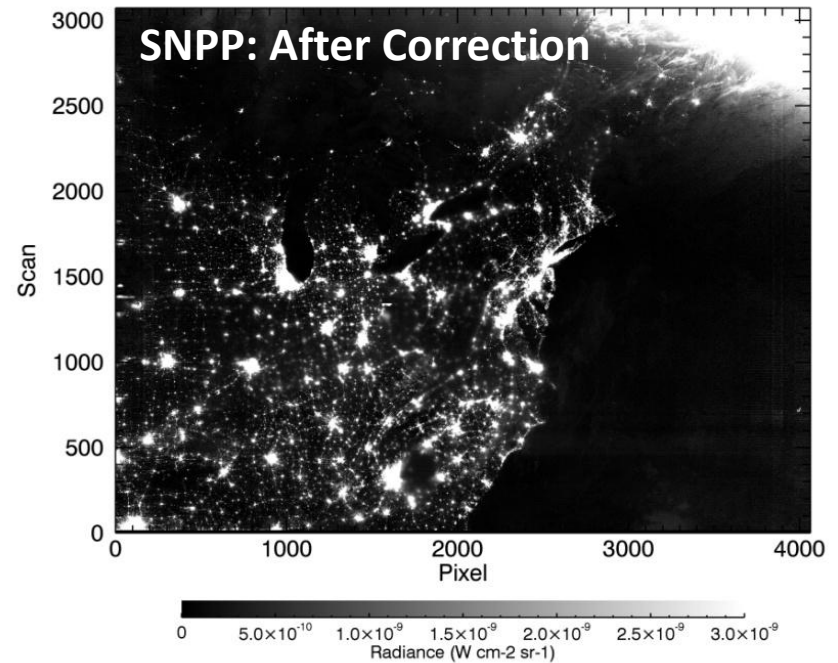
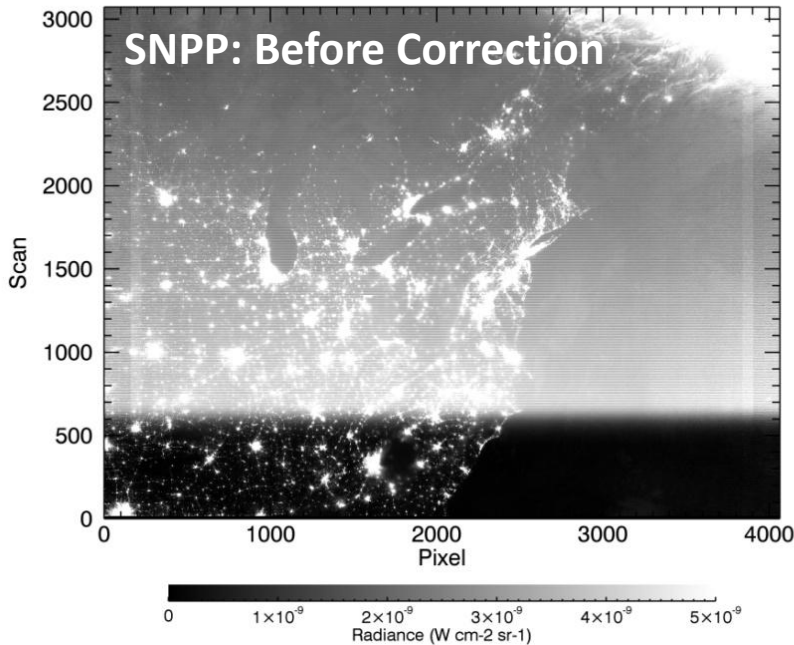


DNB Stray Light Correction



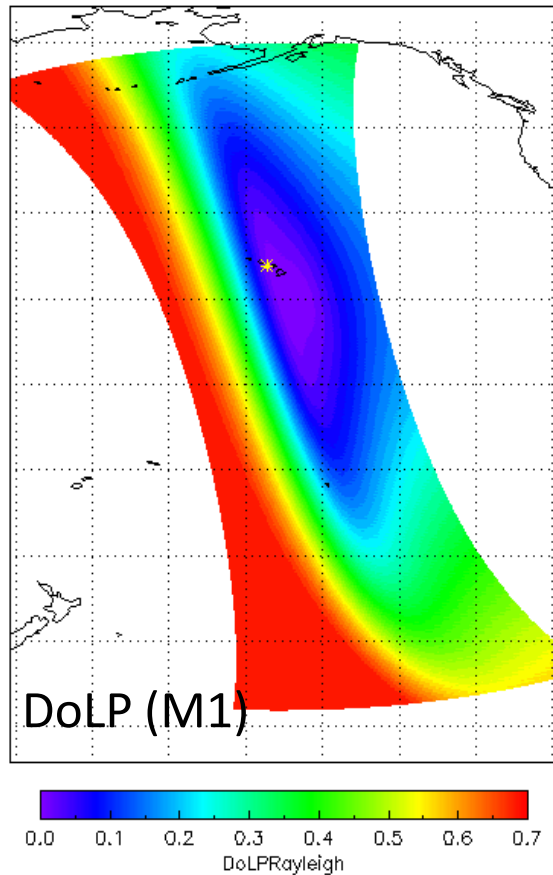
- **SNPP DNB observations are affected by stray light.**
 - Especially at high latitude
 - Can affect regions as south as 33° latitude in the NH during summer.
- **NG developed methodology for SNPP DNB stray light correction (adopted by IDPS for operational processing)**
- **STAR successfully transitioned the SNPP DNB Stray Light correction from NG to STAR in 2014**
- **STAR has been supporting operational stray light LUT updates with solar vector error correction since January 2015.**

DNB Stray Light Correction



- J1 VIIRS DNB is expected to have similar stray light issue as SNPP.
- SNPP stray light correction tool may need to be modified due to J1 DNB aggregation mode change. STAR will further investigate the issue after J1 is launched.

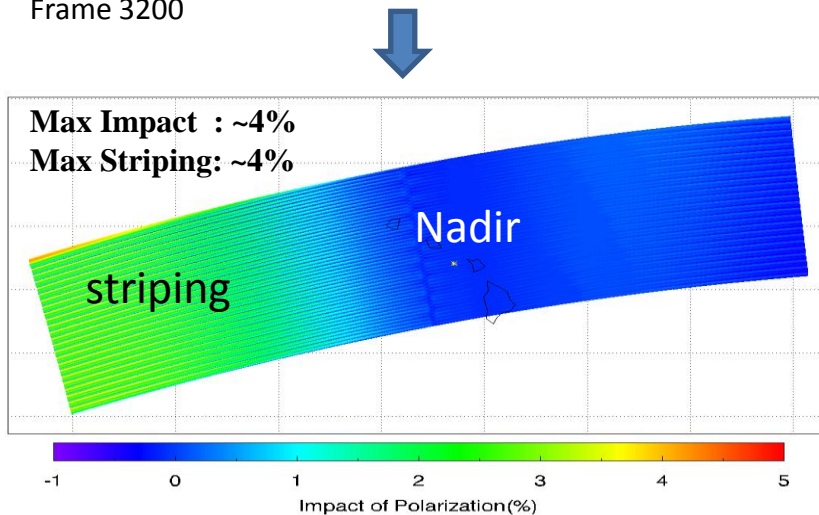
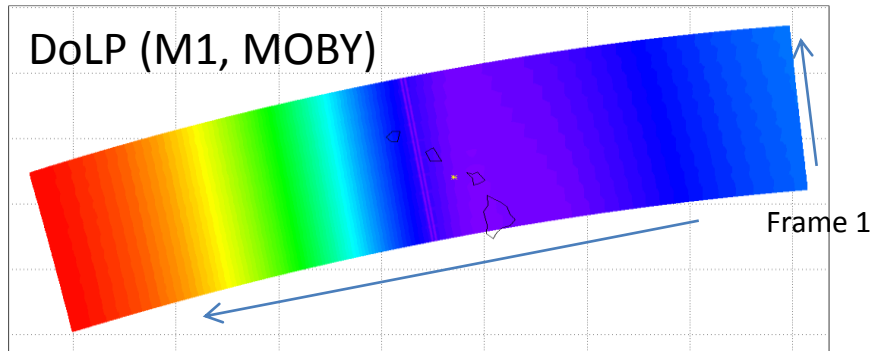
Impacts of J1 VIIRS Polarization Sensitivity on SDR



- The impacts of J1 VIIRS polarization sensitivity were analyzed using:
 - prelaunch polarization characterization data by NASA VCST
 - 6SV simulated clear-sky DoLP for a NPP VIIRS orbit over the Pacific Ocean
 - Polarization correction algorithm ([Meister et al. 2005](#))

Impacts of J1 VIIRS Polarization Sensitivity on SDR

d20140417_t2349225_e2350466



- The impact on band M1 TOA reflectance may be as large as ~4%.
- Band M1 Stripping due to HAM-side/detector level polarization sensitivity differences may also be ~4%.

- Dual calibration for SWIR
 - Completed radiometric calibration code analysis
 - Proposed dual calibration methodology to mitigate SWIR non-linearity waiver

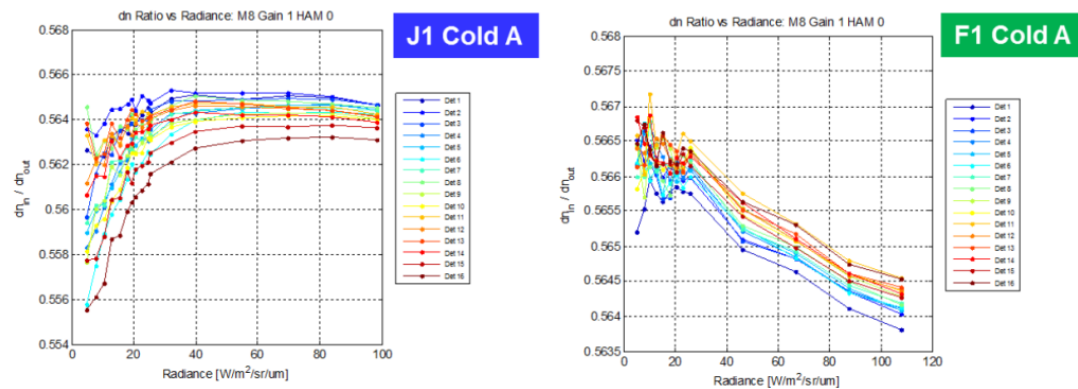


Figure 1, Ratio of sensor response value (dn) for attenuator in to attenuator out for J1 (left) and F1 (right).

Courtesy of Raytheon



Other J1 Waiver Mitigation Efforts



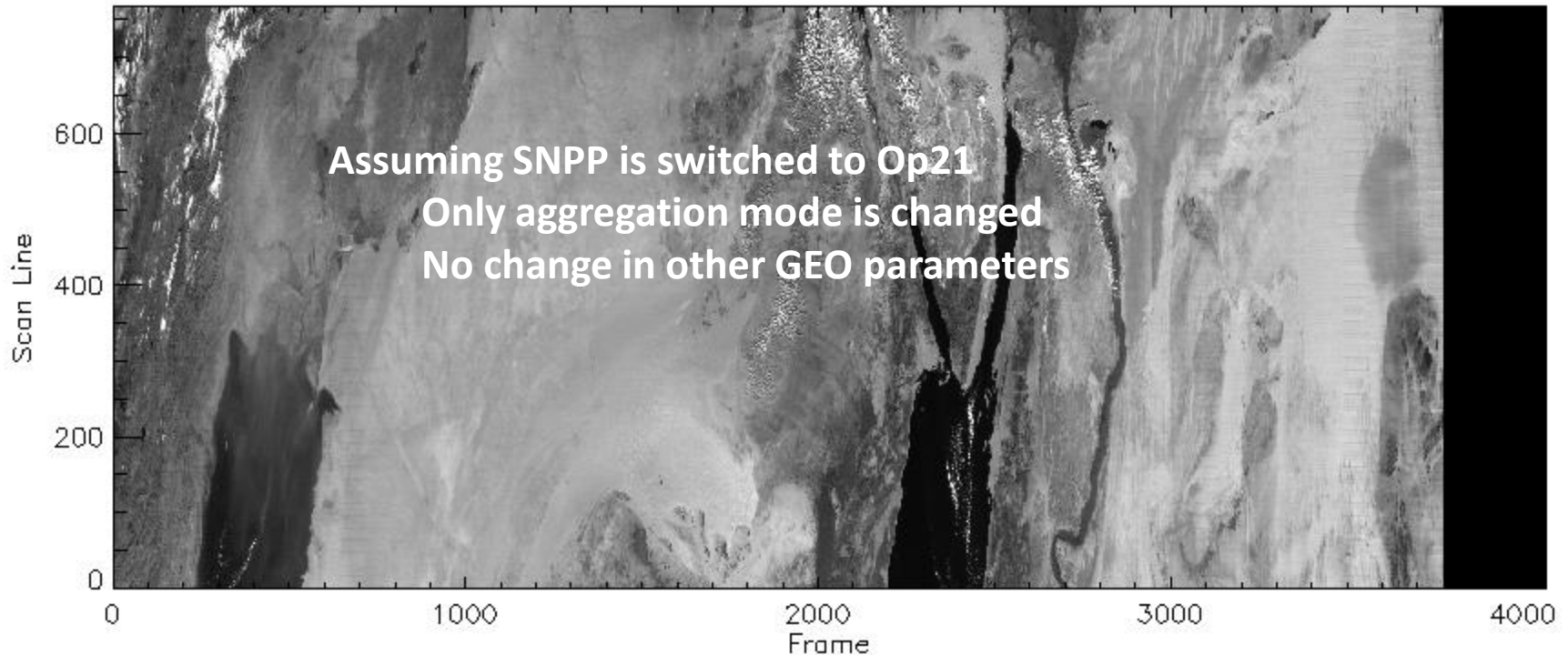
- Block 2 ADL testing
 - Successfully supported J1 GEO code change testing
 - Successfully supported J1 pre-launch DNB calibration/geolocation LUTs (Op21 & Op21/26) testing;
- Cooperated closely with the Raytheon Test Data Working Group (TDWG)
 - MDR_28: simulated J1 RDRs using SNPP radiance
 - MDR_39: J1 RDRs based on FP-X test data (DNB Op21, Op21/26)
- STAR simulated J1 DNB radiances using in-house tools
 - Simulated J1 DNB aggregation (along scan direction) using SNPP radiance
 - Used in GEO code change science test
 - May also useful for DNB NCC imagery EDR (DNB nonlinearity waiver mitigation)

Simulated J1 Op21 DNB Radiance

Using NPP Radiance + Agg zone data from NPP and J1 Op21

d20120121_t1032434_e1034076

Frame 3764



Note: this method can simulate Op21 effect in the scan direction,
But cannot simulate the Op21 effect in the track direction, also cannot simulate J1 DNB non-linearity effect.

No simulated J1 Op21 radiances after frame 3764, set to 0.



Summary and Future Works



- **STAR VIIRS SDR Team has provided strong supports for J1 VIIRS waiver mitigations.**
 - Successfully completed VIIRS GEO code change package and delivered on schedule;
 - Successfully completed the transition of DNB stray light correction from NG to STAR;
 - Assessed the impacts of J1 polarization sensitivity on SDR;
 - Obtained strong Block 2 ADL testing capabilities
- **Next Step: continue to support J1 VIIRS waiver mitigations**
 - Dual calibration for SWIR nonlinearity mitigation research;
 - Adapt SNPP DNB stray light correction methodology to J1;
 - Support other waiver mitigations, such as M8/M9/I3 saturation;
 - Assess the impact of noisy detector (I3, D4).